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ABSTRACT

This paper presents aspects of modeling, authoring, and presenting structured documents corresponding to teaching material presented in the World Wide Web. In this context, the importance of providing the formalization of the structure of the documents using Standard Generalized Markup Language (SGML) is discussed. Next, specifications for structured documents corresponding to didactic texts and questionnaires are presented; examples of two Document Type Definitions (DTDs)--Teaching Material Markup Language (TMML) and Questionnaire Markup Language (QuestML)--are included. The HyperBuilder and QuestBuilder software tools for the authoring and presentation of those documents are then discussed. The paper concludes with a discussion of related work and next steps of this research. Six figures present a diagram of the target environment, the TMML DTD, the QuestML DTD, the architecture of the components, the HyperBuilder interface, and the QuestBuilder interface. (Author/AEF)

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Tools for Authoring and Presenting Structured Teaching Material in the WWW

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Abstract: This paper presents aspects of modeling, authoring and presenting structured documents corresponding to teaching material presented in the World Wide Web. In this context, it is discussed the importance of providing the formalization of the structure of the documents using SGML. Next, specifications for structured documents corresponding to didactic texts and questionnaires are presented. Software tools to the authoring and presentation of those documents are then discussed. The paper concludes with a discussion on related work and next steps of this research.

1. INTRODUCTION

The increasing interest in providing teaching material available in the WWW has lead to the development of many HTML documents by teachers and authors of teaching material. Because most tools for generating such documents were built with a generic document model in mind, authors have little support to implement any necessary structure. Important work has been done in terms of providing support to the authoring process of teaching material by casual novice users, a case in point is the Web Course Tools (WebCT) developed at University of British Columbia [WebCT 1997].

Another issue in this area is related to static nature of HTML documents: every student is exposed to the same information, regardless of their experience or background. In order to provide customized content information to students, Brusilovsky et al. presents a tools for generating adaptative hyperbooks from annotated RTF (rich text format) documents [Brusilovsky et al. 1996]. As the WebCT case, however, the format of the documents is proprietary such that only their tools are able to built and explore the document structure and control the presentation. As far as the provision for the interchange of documents containing teaching material is concerned, Tinoco et al. report work on modeling quizzes using SGML (Standard Generalized Markup Language) [ISO 1986]. This means that the documents containing a quiz is marked so as to conform with a

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formally defined structure, and as such can be used by any software tool able to process the SGML markup. In their work, quizzes are stored in a server so that they can be accessed and solved by students: the answers are sent back to the server and processed, the achieved score being stored for further processing [Tinoco et al. 1996]. In this context, this paper presents a set tools supporting the authoring of teaching material structured using SGML, as well as the presentation of the material in the WWW. Next section the modeling of the domain using a well-known method from the hypermedia literature. Using simplified SGML notation. Section 3 formalizes the structure of documents corresponding to generic teaching material and questionnaires, whereas Section 4 presents tools for authoring and presenting the corresponding documents. Section 5 presents final remarks and future work.

2. A MODEL FOR THE EDUCATIONAL DOMAIN

The Relationship Management Methodology (RMM) was used to define the initial model for the domain where the teaching tools and associated material is to be applied. The methodology has been built to be used in domains where classes of objects have relationships among them, and where multiple instances of objects are related to each class. As it has already been demonstrated by the proponents of the methodology, the educational domain meets both requirements [Isakowitz et al. 1995].

The model presented in the Figure 1 is generic so as to be applied to many educational domains, and is in accordance, for instance, to the Hypermedia-Based Learning Environment [Nykäne and Ala-Rantala 1997] and Framework for Hyperbook Design [Fröhlich and Nejdl 1997].

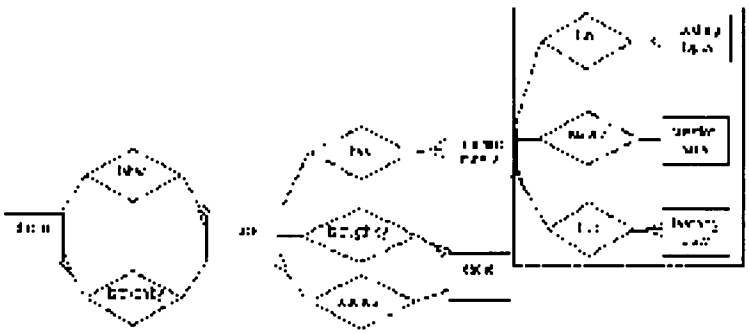

Figure 1 - E-R diagram for the target environment

The work reported here took a different approach: instead of providing a graphical slice diagram for each entity to be presented to the user, a SGML-based DTD was built. In the DTD, both the information contained within the entity and the relationships with other entities defined in the E-R diagram are specified. This is also an advantage over less formal directions as those presented by Bevirt [Bevirt 1996]. As a result of this approach, DTDs for the entities teaching material, class topics, questionnaire where built; two of them are detailed in the next section.

3. STRUCTURED TEACHING MATERIAL AND QUESTIONNAIRE

The SGML standard was proposed to allow the formalization of the structure of documents stored in an electronic medium. SGML demands that definition of the document structure be performed independently of the presentation form of the document. The advantage of using such a standard is that the documents, stored in some electronic medium, can be processed by any compliant environment, whether it is related to authoring, storage or presentation of such documents. A DTD defines a class of documents establishing definitions for elements, attributes and entities. Three DTDs were defined in the context of the educational domain presented in the previous section: a DTD for teaching material, Teaching Material Markup Language - TMML; a DTD for questionnaires, Questionnaire Markup Language - QuestML; and a DTD for teaching tasks, Teaching Tasks Markup Language – TTML.

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3.1. THE TEACHING MATERIAL MARKUP LANGUAGE - TMML

Figure 2 presents a simplified version of a DTD for teaching material, the TTML. A TTML document has elements in three levels, corresponding to the elements head, body and tail.

```
<! Simplified DTD for Teaching Material: TTML -- >
<! Elements min content -- >
<!ELEMENT TTML - - (HEAD, BODY, TAIL) >
<!ELEMENT HEAD - - (TITLE, SUBJECT, LEVEL, AUDIENCE,
 ABSTRACT, AUTHOR) >
<!ELEMENT BODY - - (ITEM)+ >
<!ELEMENT TAIL - - (TASK*, QUESTIONNAIRE) >
<!ELEMENT TITLE - O (#PCDATA) >
<!ELEMENT SUBJECT - O (#PCDATA) >
<!ELEMENT LEVEL - O (#PCDATA) >
<!ELEMENT AUDIENCE - O (#PCDATA) >
<!ELEMENT ABSTRACT - O (#PCDATA) >
<!ELEMENT AUTHOR - O (#PCDATA) >
<!ELEMENT ITEM - - (TITEM,SUBITEM)+ >
<!ELEMENT TITEM - - (#PCDATA) >
<!ELEMENT SUBITEM - - (#PCDATA|(TSUBITEM,P)+) >
<!ELEMENT TSUBITEM - - (#PCDATA) >
<!ELEMENT P - - (#PCDATA)+ >
<!ELEMENT TASK - - (#PCDATA) >
<!ELEMENT QUESTIONNAIRE - - (#PCDATA) >
<!-- element name attribute name value default -->
<!ATTLIST TTML STATUS (OK,DRAFT) DRAFT
ID ID #IMPLIED >
<!ATTLIST ITEM ID ID #IMPLIED
IDREF IDREF #CONREF >
<!ATTLIST SUBITEM ID ID #IMPLIED
REFID IDREF #CONREF >
```

Figure 2 - Simplified DTD for Teaching Material: TTML

A head element contains a set of mandatory elements: title, subject, author, level, target audience, abstract and author. The body element is composed by any number of nested items and sub-items elements, each one having its own title part. The tail element allows the specification of a list of optional tasks, followed by a mandatory specification of the associated questionnaire.

3.2. THE QUESTIONNAIRE MARKUP LANGUAGE - QuestML

Figure 3 presents a simplified version of a DTD for a questionnaire, the QuestML. Similarly to TTML, a QuestML document has elements in three levels: head, body and tail. A head element has all the elements of the TTML head but the abstract element; an optional comment element is allowed instead. The body element is composed by any number of nested questions. Three types of questions are defined: truefalse, choice and open.

```
<!-- Simplified DTD for Questionnaire:QuestML -->
<!-- elements min content -->
<! ELEMENT QUESTML - - (HEAD, BODY, TAIL) >
<!ELEMENT HEAD - - (TITLE, SUBJECT, LEVEL, AUDIENCE, COMMENT?, AUTHOR) >
<!ELEMENT BODY - - (QUESTION)+ >
<!ELEMENT TAIL - - (SUBMIT?) >
<!ELEMENT TITLE - O (#PCDATA) >
<!ELEMENT SUBJECT - O (#PCDATA) >
<!ELEMENT LEVEL - O (#PCDATA) >
<!ELEMENT AUDIENCE - O (#PCDATA) >
<!ELEMENT COMMENT - O (#PCDATA) >
<!ELEMENT AUTHOR - O (#PCDATA) >
<!ELEMENT QUESTION - - (TRUEFALSE | CHOICE | OPEN) >
<!ELEMENT TRUEFALSE - - (OPTION) >
<!ELEMENT CHOICE - - (TEST, OPTION+) >
<!ELEMENT OPEN - - (TEST, NOPTION) >
<!ELEMENT TEST - O (#PCDATA) >
<!ELEMENT OPTION OO (WHAT,WHY?,WHERE?) >
<!ELEMENT NOPTION OO (WHY,WHERE?) >
<!ELEMENT WHAT - O (#PCDATA) >
<!ELEMENT WHY - O (#PCDATA) >
<!ELEMENT WHERE - O EMPTY >
<!ELEMENT SUBMIT - - EMPTY >
<!-- element name value default -->
<!ATTLIST QUESTML STATUS (OK | draft) draft
ID ID #IMPLIED >
<!ATTLIST QUESTION ID ID #IMPLIED
IDREF IDREF #CONREF >
<!ATTLIST TRUEFALSE KEY (true | false) true >
<!ATTLIST CHOICE KEY NUMBERS #REQUIRED
MULTI (true | false ) false >
<!ATTLIST OPEN WHO CDATA #CURRENT >
<!ATTLIST WHERE IDREF IDREF #CONREF >
```


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Figure 3 - Simplified DTD for Questionnaire: QuestML

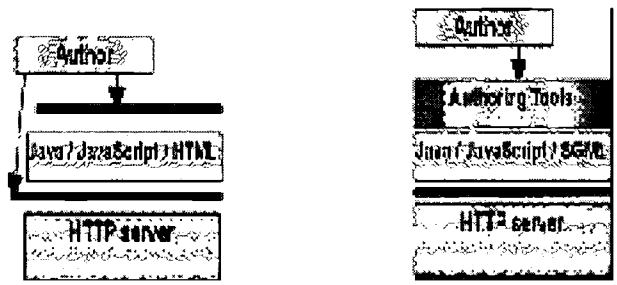
The body element is composed by any number of nested questions. Three types of questions are defined: truefalse, choice and open. A truefalse question has a single option element, which corresponds to the concept a student has to agree or disagree with. A choice question has a test part and an option part. The test correspond to what concept is being evaluated, and the options part correspond to a set of concepts the user can select. Each option is composed of a what element (the question itself) and optional why and where elements. The why element is supposed to state why the select option is or not correct, whereas the where element can indicate, via a hypertext link, a point where that particular subject is discussed. A open question has a test part and a noption part. The noption element is equivalent to the option element without the what part, since that the user is supposed to freely reply to the question proposed by the test part.

After the presentation of the DTDs, the next section discusses aspects of using such structures from the point of view of tools for authoring and presenting the related information.

4. AUTHORING AND PRESENTING TTML AND QUESTML DOCUMENTS IN THE WWW

The aim of the work here reported is not only to facilitate the creation of the structures documents, but also to allow them to be presented in the WWW. Moreover, for the QuestML documents, a user (student) should be allowed to answer the questions while using a WWW browser and receive the associated score.

Figure 4a presents a general architecture of the components used in the WWW to present interactive documents. In further, the general approach adopted in this work was to build tools that would help the authoring of the structure of the documents in order that they could, then, be extended with HTML contents using and presented in the WWW. This is illustrated in Figure 4b, where a new level corresponding to the tools isolates the author from the details of authoring and publishing.



(a) (b)

Figure 4– (a) General architecture of the components used in the WWW. The arrows represent the Interfaces between an author and the languages used in the WWW. (b) Architecture extended with tools that allow the authoring, publishing and presenting of SGML-based documents extended with Java and Javascript.

In this context, a set of tools was implemented at support the authoring both teaching material and questionnaires.

4.1. AUTHORING AND PRESENTING STRUCTURED TEACHING MATERIAL

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HyperBuilder is a tool that guides the authoring of the elements corresponding to the TTML DTD. The approach is to present to the author the several elements allowed in the document; as the author completes the contents for those elements, a document reflecting the TTML structure is built.

HyperBuilder, illustrated in Figure 5a, allows an author to include the elements the document, according to the structure defined in the TTML DTD. First-level elements, such as title and abstract, have their contents inserted in the main document, while items and subitems are associated to new files corresponding to lower levels in the hierarchy of the document. At any time, HTML existing contents can be imported to any of the documents in the hierarchy. When a file is saved, the main TTML document is saved along with a set of HTML related files. The author has an option to presenting the hierarchy using frames or and an index embedded in the main document. Another option allows the HTML files to be published in a WWW server, from where they can accessed from any web browser, as shown in Figure 5b.

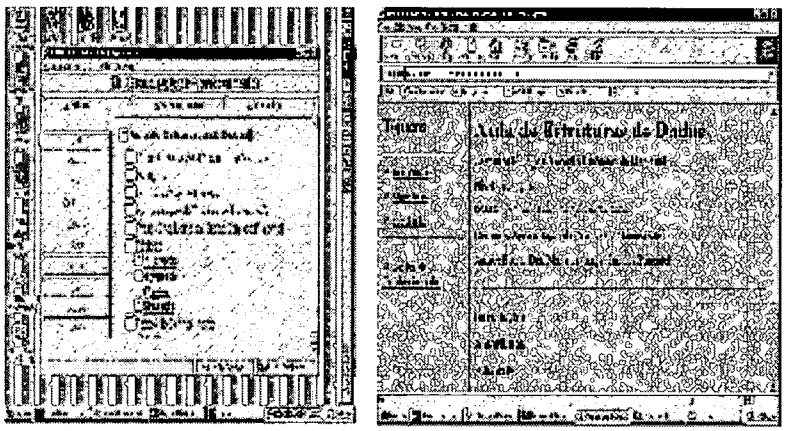

Figure 5: (a) HyperBuilder interface. (b) A TTML-based document presented in the WWW

4.2. AUTHORING, PRESENTING AND EVALUATING STRUCTURED QUESTIONNAIRES

Figure 6a illustrates the use of the QuestBuilder tool, which allows the authoring of a QuestML document. Similarly to TTML documents, QuestML questionnaire can also be published directly a the WWW server. Because a questionnaire is one of the elements of a TTML document, a user accesses a questionnaire when the link test is activated in the corresponding TTML document (Figure 6b).

The fact that the Java language allows fine interaction and computation in the browser has been exploited in this tool. Since the correct answer is part of the content of test-based questions, these can be automatically evaluated when a student finishes a questionnaire. The answers are only shown when a minimum score is achieved, as specified by the MIN element. When open questions are used, the answer is mailed to the person specified by the element WHO in the question. The element SUBMIT will be used when the tools are integrated within the database, in order to keep track of the evolution of the student.

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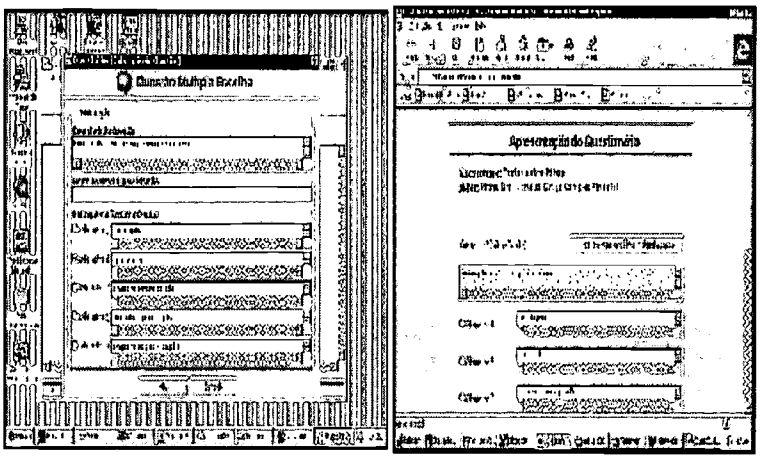

Figure 6: (a) QuestBuilder interface. (b) A QuestML-based document presented in the WWW

5. FINAL REMARKS

Gaines remarks that the growth of the Internet and the WWW, and the evolution of their underlying technologies, may contribute to the foundations of the knowledge science [Gaines 1996]: there is no doubt that exploiting such an environment in the educational domain may bring many contributions. Important work has been done in terms of providing environments where teachers and students can interact, produce and navigate through course-related documents.

This paper has presented undergoing work aimed at building an environment that supports teaching and learning activities in the WWW. The highest level of the entities and their relationship have been presented. An important step was taken in terms of creating document type definitions (DTDs) from the entities and relationships identified. Such mapping, which has guided both the construction of the related authoring tools and defined presentation and navigation structures, has not yet been reported in the literature.

Specifications for structured documents containing teaching material and questionnaire have been discussed, tools associated to the authoring of those documents presented, and the approaches for presenting the documents indicated. At the time of this writing, the environment that will integrate the documents stored in the WWW server with the remaining information related to the courses (Figure 1) is under construction.

The work reported has advantages over other reported in the literature because: (a) the documents supported are structured according to a standardized language; (b) the clients and servers are freeware and platform independent; (c) the tools for authoring and presentation built are also platform independent since Java has been used in all implementations.

The next steps of this work include (a) concluding the tools allowing the storage and retrieval of the documents and other related information from a database; (b) experimenting the tools with novice and casual teachers and students; (c) exploring alternative linking structure within the hyperdocuments, as proposed in [Pimentel and Bufford 1996]; and (d) further investigating the integration of a DTD construction phase in hypermedia design models.

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